

FORM PTO-1390
(REV 10-97)

U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

DATE: November 15, 2000

EXPRESS MAIL LABEL NO.
EL496185273USATTORNEY DOCKET NO.
40954/DBPU.S. APPLICATION NO.
09/700572INTERNATIONAL APPLICATION NO
PCT/EP99/03359INTERNATIONAL FILING DATE
17 May 1999PRIORITY DATE CLAIMED
15 May 1998

TITLE OF INVENTION

**METHOD AND DEVICE FOR AUTOMATIC DETECTION AND TESTING OF GEOMETRIC AND/OR
TEXTURAL CHARACTERISTICS OF AN OBJECT**

APPLICANT(S) FOR DO/EO/US

MUNZKE, Karl-Heinz; BISCHOFF, Volker; and KRZYWINSKI, Ronald

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)).
 - a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/LUS).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☐ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). (Unexecuted)
10. ☒ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items below concern other document(s) or other information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
 - ☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☐ SMALL ENTITY Assertion: Applicant(s) and any others associated with it/them under 37 CFR § 1.27(a) are a small entity.
17. ☒ International search report.
18. ☒ International preliminary examination report.
19. ☒ Extra Set of Drawings, including the amended Fig. 3
20. ☐
21. ☐

U.S. APPLICATION NO. (If known, see 37 CFR 1.5) To be assigned 09/700572		INTERNATIONAL APPLICATION NO PCT/EP99/03359		ATTORNEY DOCKET NO. 40954/DBP	
<input checked="" type="checkbox"/> The following fees are submitted: (see Note (1) below) Basic National Fee (37 CFR 1.492(a)(1)-(5)): Search Report has been prepared by the EPO or JPO \$860.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) ... \$690.00 No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1.445(a)(2)) \$710.00 Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO \$1,000.00 International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) \$100.00 <div style="text-align: right;">ENTER APPROPRIATE BASIC FEE AMOUNT =</div>				CALCULATIONS	PTO USE ONLY
Surcharge of \$130 for furnishing the oath or declaration later than <input type="checkbox"/> 20 <input checked="" type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(e)).				\$ 130	
Claims	Number Filed	Number Extra	Rate		
Total Claims	14+3 -20=	0	X \$18	\$ 0	
Independent Claims	2 -3=	0	X \$80	\$ 0	
Multiple dependent claim(s) (if applicable)			+ \$270	\$ 270	
TOTAL OF ABOVE CALCULATIONS =				\$ 1260	
Reduction by 1/2 for filing by small entity, if applicable. Verified Small entity statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28).				\$	
SUBTOTAL =				\$ 1260	
Processing fee of \$130 for furnishing the English translation later than <input type="checkbox"/> 20 <input type="checkbox"/> 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				\$	
TOTAL NATIONAL FEE =				\$ 1260	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property				\$	
TOTAL FEES ENCLOSED =				\$ 1260	
Note (1): The basic national fee must be paid when filing this application. The 20-month time limit (37 CFR § 1.494) and 30-month time limit (37 CFR § 1.495) are not extendable.				Amount to be:	
				refunded	\$
				charged	\$
<p>a. <input checked="" type="checkbox"/> A check in the amount of \$ 1260.00 to cover the above fees is enclosed.</p> <p>b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of \$ _____ to cover the above fees. A duplicate copy of this sheet is enclosed.</p> <p>c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 03-1728. A duplicate copy of this sheet is enclosed.</p> <p>NOTE (2): Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.</p> <p>SEND ALL CORRESPONDENCE TO:</p> <p>D. Bruce Prout CHRISTIE, PARKER & HALE P.O. Box 7068 Pasadena, CA 91109-7068</p> <p>CUSTOMER NUMBER: 23363</p> <div style="text-align: right; margin-top: 20px;"> By <u><i>D. Bruce Prout</i></u> D. Bruce Prout Reg. No. 20,958 </div>					

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Express Mail No.: EL483387541US

Applicant : Karl-Heinz Munzke, et al.
Application No. : 09/700,572
Filed : November 15, 2000
Title : METHOD AND DEVICE FOR AUTOMATIC DETECTION AND
TESTING OF GEOMETRIC AND /OR TEXTURAL CHARACTERISTICS
OF AN OBJECT
Grp./Div. : N/A
Examiner : N/A
Docket No. : 40954/DBP/E43

VERIFIED STATEMENT CLAIMING SMALL ENTITY STATUS
AND REQUEST FOR PARTIAL REFUND

Assistant Commissioner for Patents
Washington, D.C. 20231

P.O. Box 7068
Pasadena, CA 91109-7068
April 20, 2001

Commissioner:

Applicant hereby claims Small Entity status as of the date of payment of the fee.

A fee in the amount of \$1260.00 was paid on November 15, 2000 as a non-small entity status. The excess over a small entity fee is \$630.00.

Applicant hereby requests that a refund of the excess fee be made by check with this firm as payee. Please indicate our docket number on the check. **A copy of this request is enclosed.**

Respectfully submitted,

CHRISTIE, PARKER & HALE, LLP

By Mark Gausman (31,953)

For D. Bruce Prout
Reg. No. 20,958
626/795-9900

DBP/aam

Enclosure: Copy of this request

Docket No. : 40954/DBP/E43 CHRISTIE, PARKER & HALE, LLP
Post Office Box 7068
Applicant or Patentee : Karl-Heinz Munzke, et al. Pasadena, CA 91109-7068
Application or Patent No. : (626) 795-9900
Filed or Issued : November 15, 2000
Entitled : METHOD AND DEVICE FOR AUTOMATIC DETECTION AND
TESTING OF GEOMETRIC AND/OR TEXTURAL CHARACTERISTICS
OF AN OBJECT

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37) CFR 1.9(f) & 1.27(c) – SMALL BUSINESS CONCERN**

I hereby declare that I am

_____ the owner of the small business concern identified below:

☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF SMALL BUSINESS CONCERN : Bi-Ber Bilderkennungssysteme GmbH Berlin

ADDRESS OF SMALL BUSINESS CONCERN : ~~Muggelseedamm 221, D-12587 Berlin, Germany~~
Ostendstraße 25, D-12459

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.12, and reproduced in 37 CFR 1.9(d), for the purposes of paying reduced fees to the United States Patent and Trademark Office, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement, (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention entitled **METHOD AND DEVICE FOR AUTOMATIC DETECTION AND TESTING OF GEOMETRIC AND/OR TEXTURAL CHARACTERISTICS OF AN OBJECT** by inventor(s) **Karl-Heinz Munzke, Volker Bischoff, and Ronald Krzywinski** described in

_____ the specification filed herewith

☒ Application No. _____ filed November 15, 2000

_____ Patent No. ___ issued ___

If the rights held by the above identified small business concern are not exclusive, each individual, concern or organization having rights in the invention is listed below* and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e). *NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

NAME :

ADDRESS :

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY STATUS
(37) CFR 1.9(f) & 1.27(c) - SMALL BUSINESS CONCERN

Docket No.: 40954/DBP/E43

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

NAME :

ADDRESS :

☐ INDIVIDUAL ☐ SMALL BUSINESS CONCERN ☐ NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28(b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING : *DIPL-ING. RONALD KRZYWINSKI*
TITLE OF PERSON IF OTHER THAN OWNER :
ADDRESS OF PERSON SIGNING : *HÖRIKESTR. 34, D-12437 BERLIN*

SIGNATURE *R. Krzywinski* DATE *03/12/00*

DBP/aam

ODMA\HODMA\CPH\PAS,285905,1

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

EXPRESS MAIL NO. EL496185273US

Applicant : Karl-Heinz Munzke, et al.
Filed : November 15, 2000
Title : METHOD AND DEVICE FOR AUTOMATIC DETECTION
AND TESTING OF GEOMETRIC AND/OR TEXTURAL
CHARACTERISTICS OF AN OBJECT
Docket No. : 40954/DBP/E43

PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Post Office Box 7068
Pasadena, CA 91109-7068
November 15, 2000

Commissioner:

Please amend the above-identified application as follows:

IN THE CLAIMS:

Claim 4, line 1, delete "one of the preceding claims", and insert --claim 1--.
Claim 5, line 1, delete "one of the preceding claims", and insert --claim 1--.
Claim 6, line 1, delete "one of the preceding claims", and insert --claim 1--.
Claim 11, line 1, delete "one of claims 7 through 10", and insert --claim 7--.
Claim 12, line 1, delete "one of claims 7 through 11", and insert --claim 7--.
Claim 14, line 1, delete "one of claims 7 through 13", and insert --claim 7--.

REMARKS

In view of the foregoing amendments, consideration and allowance of this application is respectfully requested.

Respectfully submitted,
CHRISTIE, PARKER & HALE, LLP

By D. Bruce Prout
D. Bruce Prout
Reg. No. 20,958
626/795-9900

DBP/aam

4/PRTS

09/700572
528 Rec'd PCT/PTO 15 NOV 2000

Berlin 17th May 1999
Our ref: BB9008 JVO/js
Applicants/proprietors: Bi-Ber Bilderkennungssysteme GmbH Berlin
Office ref: New application

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Bi-Ber Bilderkennungssysteme Berlin
Müggelseedamm 221, 12587 Berlin

Method and apparatus for automated detection and checking of geometrical
and/or textural features of an object

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The invention concerns a method as set forth in the classifying
portion of claim 1 and an apparatus for carrying out the method.

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The invention lies in the technical field of optically checking various
views of an object, which is to be carried into effect for example in the
process of circuit production and assembly.

20

In regard to circuit production and assembly it is particularly
necessary to check the prints on the top side of circuits in terms of their
existence there and their quality (discernibility) in order to prevent
confusions from occurring. In addition it is necessary to measure the
connections ('terminal or connection legs') which are disposed at the
underside of the circuits, to ascertain whether they all lie within a
predetermined tolerance range in one plane so that for example in a
subsequent soldering process they can be simultaneously and reliably
involved with the solder. That checking operation or ascertaining the

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deviation of the ends of the terminal legs from a flat contact surface is
referred to as coplanarity checking. This coplanarity checking operation can
be effected from a side view on to the rows of terminal legs at the sides of
the circuit. Besides the above-mentioned print quality assessment and the
coplanarity checking, the housing bottom clearance of a component and
pitch, twist or skew, width, position, length deviation and contact point of
30 the terminal connections are measured in the context of a so-called 'lead
and mark inspection'.

Automatic reading of plain text on products is state of the art; see for example R Koy-Oberthür: 'Übersicht industrieller Anwendungen der Klarschrift- und Barcode-identifikation', Symposium: Aktuelle Entwicklungen und Realisierungen der Bildverarbeitung, 11th and 12th
5 September 1997, Aachen, Ministerium für Wirtschaft, Mittelstand und Technologie des Landes Nordrhein-Westfalen. The aim pursued by that procedure is to recognise the individual symbols contained in the script, but not to derive an assessing measurement in terms of the readability afforded in any way thereby. It is precisely this however that is necessary
10 and appropriate for such situations if the content of the printing is known per se but its potential readability has to be guaranteed, for example for liability and monitoring situations.

The lecture by T Schroeter: 'Einsatz der Bildverarbeitung zur Druckvollständigkeitskontrolle' at the same Symposium described a method
15 which detects the completeness of printing, that is to say checks it for missing characters. That method makes use of the so-called histogram information. The method described herein assesses the printed area without deriving an evaluation in terms of the readability of the identification.

It is also known to implement a coplanarity check on circuits by means of optical methods with which gap widths can be measured. In the procedure described by Qtec in 'Industrielle Bildverarbeitung/Maschine Vision', VDM, Robotik Automation, Maschinenbau Verlag GmbH, Frankfurt/Main. 1997, an image is taken from the underside of the circuit to
20 be checked, that image permitting a view on to shadows cast by the rows of connection legs. A disadvantage in this respect is that evaluation is effected only from one image which is recorded directly from an individual side of the object to be monitored, and thus it is not possible also to implement a print quality check. The location of the shadow of a connection
25 leg to be measured, on a base surface, is moreover influenced not only by the distance thereof from the base surface (on which the shadow is cast) but also the location of the connection leg over that base surface, and moreover the specific shape of the connection leg, from which major errors
30

can result. Furthermore, with this procedure, a plurality of individual light sources are required to produce an evaluable shadow image.

The coplanarity monitoring unit SMD9000 from Trigon Adcotech uses five CCD-cameras for recording the images to be evaluated, for monitoring
5 coplanarity, one for each side view and one for a plan view. A disadvantage in this respect is the high level of technical complication and expenditure arising out of the number of cameras required, and the fact that the individual views are not linked to each other.

In addition WO 98/04882 discloses a method of the general kind set
10 forth for the automated detection and checking of geometrical and textural features of an IC component in side views and a plan view. In that case detection of the features is effected using a CCD-camera and a corresponding storage unit and evaluation unit for image processing and image evaluation. In that case, quality and state assessment of the object
15 is effected by a comparison with parameters which are predetermined in respect of the individual features, wherein the partial images of the object are substantially simultaneously recorded by means of a single CCD-camera by virtue of a suitable beam-deflection device and are at least partially assembled optically at the same time to form an overall image
20 which shows all views and in which the boundaries of the partial images can be recognised. The overall image is then separately evaluated for checking the individual features in the boundaries of the partial images. In this case the coplanarity of the legs of the IC-component is also checked. That publication however does not disclose the form in which that evaluation
25 procedure is implemented.

Therefore the object of the present invention is to provide a method and an apparatus which make it possible at relatively low cost to detect and check in interrelated manner and reliably in relation to coplanarity structural and/or textural features of an object in a plurality of views, more
30 especially in a plan view and in side views.

In regard to its method aspect that object is attained by a method having the features of claim 1 and in regard to its apparatus aspect by an apparatus having the features recited in claim 7.

The invention involves the technical teaching of obtaining from a single viewing position by means of suitable optical means an overall image constructed from partial images of various views of the object with a level of resolution which is sufficient for simultaneous structure and texture checking.

The partial images are substantially simultaneously recorded and at least partially brought together optically at the same time to form an overall image showing all views, in which the boundaries of the partial images can be seen, and that is evaluated in the boundaries of the partial images separately - that is to say with different evaluation means or in terms of different parameters.

In accordance with the invention firstly in the regions of the overall image which show side views on to the object, analysis of the gray value distributions is effected to ascertain locations in which parts (to be checked in terms of coplanarity) of the object come very close to a substrate. Subsequently the light quantity which passes through between the object and the substrate and which is reflected at the pixels as an intensity value is detected and, utilising the intensity values, the local light quantity pattern or configuration which characterises the width of a gap between the object and the substrate is determined. Finally the light quantity pattern or configuration can be converted into a gap width in accordance with a predetermined algorithm, utilising calibration information. The rule for conversion of an intensity pattern as between object and support is advantageously implemented on the basis of a spline approximation, the determination of rise values and calibration, in such a way that an area proportion under the spline curve determines the value of the gap width between the object and the support surface. That procedure is expedient especially for coplanarity checking of circuits or similar objects.

In a preferred embodiment all partial images are assembled optically and recorded by precisely one image-recording device, wherein in the overall image the regions of the partial images are so positioned and characterised, in particular using the storage unit and/or the evaluation

unit, in such a way that they can be associated for the evaluation procedure with the individual views.

Checking the object is made easier in many uses if in at least one additional step the scene is recorded without an object and/or with a
5 reference object which has predetermined parameters in regard to the features, and the corresponding overall image is stored in the storage device for comparison and calibration purposes.

In a region of the overall image (which for example shows the plan view of a circuit), for the purposes of detecting a texture and especially for
10 checking the readability of a characterisation or identification, preferably by means of image processing, using convolution filters, areas with severe local intensity differences are emphasised, detected and quantified in terms of their dimensions, the result of the quantification operation in the above-mentioned areas is compared to given values and subsequently quality
15 information is derived in respect of the texture or identification.

In the apparatus according to the invention there is provided a flat support surface for the object, and the beam-deflection means are substantially arranged in the plane of the support surface in such a way that there is a view parallel to the support surface, permitting checking of
20 the coplanarity of a plurality of parts of the object, which are towards the support surface.

The apparatus according to the invention preferably includes a single image-recording device, relative to which the object is positioned in such a way that it fills only a part of its field of view, wherein arranged in
25 remaining parts of the field of view are beam-deflection devices which produce images of side views of the object on the image-recording device.

The beam-deflection devices are so positioned that they respectively produce an image of a given view of the object, but do not influence the other views (especially the plan view on to the object).

30 The means for beam deflection have in particular prisms or mirrors which are fixed or displaceable and which can have surfaces which are optionally curved for specific uses. In addition or alternatively thereto they may have a light guide arrangement (one or more glass fiber bundles).

Associated with at least one of the beam-deflection devices are means for altering the imaging scale of at least one partial image with respect to at least one other partial image, in particular a lens arrangement.

5 Furthermore the apparatus preferably includes - especially for coplanarity checking procedures - a lighting device which in particular has a light diffuser device for producing a regular light flux under the object, which is arranged behind (from the point of view of the beam-deflection device) projecting parts of the object.

10 In that case the light diffuser device can preferably be interrupted in such a way that the free spaces permit a view on to the underside of the object.

For recording a plan view, in a preferred feature a further lighting device which is suitable specifically for evaluating the recognisability of a surface texture is then arranged over the object.

15 A preferred apparatus is one in which the image-recording device and the storage and evaluation unit are integrated in a structural unit. That can be for example a so-called 'smart camera', as however is hitherto not used for lead and mark inspection. The advantages of using an integrated component are that on the one hand it is easily obtainable and on the other hand it can be easily configured for use in the context of the procedures described hereinbefore.

Advantageous embodiments of the invention are also set forth in the appendant claims, and the description hereinafter with reference to the accompanying drawings in which:

25 Figure 1 shows a diagrammatic simplified view of the overall structure of an embodiment of an apparatus according to the invention,

Figure 2 shows an overall image of an example of an object to be checked, with a plan view and side views recorded from a viewing position,

30 Figure 3 is a view of part of a further embodiment with advantageously arranged lighting devices for producing top light and relative transillumination,

Figure 4 shows a view of the intensity profile of a gap section between a support and a projecting part of an object, which is towards same,

Figure 5 shows a side view and a view from below of a component with L-shaped connections, and a side view and a view from below of a component with J-shaped connections.

Figure 1 is a diagrammatic view showing the principle of the overall structure of an apparatus for checking features, which can be recognised in side views and a plan view, of an object 1, from a single viewing position.

10 The apparatus includes a CCD-camera 2 as an image-recording device, with an objective lens 2a which has a field of view 3, a support surface 4, prisms 5 for beam deflection purposes and lenses 6 for beam formation in respect of the deflected radiation, as well as an image evaluation and storage unit 7. A lighting device is not shown; the apparatus by way of example

15 accordingly operates with diffuse ambient light.

The camera 2 records an overall image of the object 1, which is composed of a plurality of partial images of various views of the object. The light which is reflected from the top side 1a of the object and which passes directly into the objective lens 2a produces a partial image of the plan view,

20 and the light which is reflected from the side surfaces 1b and which is deflected by the prisms 5 into the objective lens of the camera produces partial images corresponding to the side views. The lenses 6 produce a change in the imaging scale or the detailing of the recorded image in the parts of the beam path which are influenced by the lenses, that is to say in

25 the partial images of the side views.

The camera 2 transmits the overall image in the form of an electrical signal pattern to the image evaluation and storage device 7 (not described in greater detail herein) which for example can be embodied by a personal computer. The image evaluation and storage unit 7 determines the

30 boundaries and demarcation of the partial images and, using image processing and image evaluation methods which are known per se but which are specifically adapted to the features to be checked in the partial

images, extracts relevant items of information and parameters from the partial images, and prepares them for comparative evaluation.

Figure 2 shows a typical overall image 11 of a circuit in the field of view 10 of the camera, the image having been recorded by the camera 2 in the apparatus shown in Figure 1 and stored in the image evaluation and storage unit 7. The overall image 10 comprises five partial images, more specifically the partial image 11a of the plan view and the partial images 11b through 11e of the side views. Printing 12 on the top side of the circuit stands out clearly in its intensity from the intensity of the ambient light. The images of the side views are formatively influenced by superposition structures 13 which include elements which are caused by gaps of different widths between the legs of the circuit 1 and the support 4. The superposition structures are evaluated by means of special image processing methods as already referred to hereinbefore and used for a checking procedure in respect of coplanarity of the circuit connections.

Figure 3 shows a detail of a modified embodiment of the arrangement shown in Figure 1, in which, in addition to the components illustrated therein, there are provided two lighting devices 8a, 8b for producing top light on the surface of the object 1 and for producing transmission light for the side views of the legs 1.1 of the circuit 1, the transmission light being rendered diffuse by a light diffuser device 9.

Figure 4 shows a spline curve S for the variation in intensity in the pixels of the digitised partial image of a side view for one of the gaps between a leg and the support. The area A_s under the spline curve S, defined by the rise points X_0 and X_1 , is used in the context of a specific image evaluation procedure for the side view partial image for computation of the gap width as a coplanarity parameter.

Figure 5 denotes the parameters checked in the context of a so-called lead and mark inspection, by reference to the side view 1b of an object 1 and by reference to the underneath view 1c thereof. The object shown at the left in Figure 5 has L-shaped connections while the object shown at the right in Figure 5 has J-shaped connections. The parameters to be checked are the coplanarity CP, the housing bottom clearance ST, the

pitch PI, the twist or skew SK, the connection or lead width LW, the length LS, the connection or lead position LP, the length deviation LED, the connection dimensions TD, the contact points or the footprint FP and the housing height (not identified).

Berlin 17th July 2000
Our ref: BB9008 MK/as
Applicants/proprietors: Bi-Ber Bilderkennungssysteme GmbH Berlin
Office ref: PCT/EP99/03359

New claims

1. A method for automated detection and checking of geometrical and/or textural features of an object (1) in various views, in particular in side views (1b) and a plan view (1a), using an opto-electronic image-recording device (2) as well as a storage and evaluation unit (7) for image processing and image evaluation, wherein quality or state assessment of the object is effected by a comparison with parameters which are predetermined in respect of the individual features, wherein a plurality of partial images (11a through 11e) of the object are substantially simultaneously recorded by means of a number of image-recording devices and beam-deflection means (5), which number is smaller than the plurality of partial images, and at least partially optically assembled at the same time to form an overall image (11) which shows all views and in which the boundaries of the partial images can be recognised, and the overall image is evaluated separately for checking the individual features in the boundaries of the partial images, characterised in that

- in the regions (11b through 11e) of the overall image, which show side views (1b) on to the object (1), locations at which the object comes very close to a support surface (4) are ascertained by analysis of the gray value distributions,
- subsequently the light quantity which passes through between the object and the support surface and which is reflected in the pixels as an intensity value is detected,
- the local light quantity pattern characterising the width of a gap between the object and the support surface is determined using the intensity values, and

- the light quantity pattern is converted in accordance with a predetermined algorithm using calibration information into a gap width which is present between the object and the support surface.

2. A method as set forth in claim 1 characterised in that all partial images (11a through 11e) are assembled optically and recorded by precisely one image-recording device (2).

3. A method as set forth in claim 1 or claim 2 characterised in that in the overall image (11) the regions of the partial images are so positioned and identified, using the storage and evaluation unit (7), that they can be associated with the individual views (1a, 1b).

4. A method as set forth in one of the preceding claims characterised in that in at least one additional step the scene is recorded without object (1) and/or with a reference object which has predetermined parameters in respect of the features and the corresponding overall image (11) is put in the storage and evaluation unit (7) for comparison and calibration purposes.

5. A method as set forth in one of the preceding claims characterised in that in a region (11a) of the overall image which shows in particular a plan view (1a), by means of image processing, using convolution filters, areas with severe local intensity differences are emphasised, detected and quantified in respect of their dimensions.

6. A method as set forth in one of the preceding claims characterised in that integrated into the overall image (11) is a representation of the side of the object (1) which is remote from the or all image-recording device or devices (2) and which is in particular towards the support surface (4).

7. An apparatus for automated detection and checking of geometrical and/or textural features of an object (1) in various views (1a, 1b), in

particular in side views and a plan view, comprising an opto-electronic image-recording device (2) and a storage and evaluation unit (7) for image processing and image evaluation, wherein there are provided optical means (5) for beam deflection, by means of which a plurality of partial images (11a through 11e) of the object are substantially simultaneously recorded by a number of image-recording devices, which number is smaller than the plurality of partial images, and are at least partially assembled optically at the same time to form an overall image (11) which shows all views and in which the boundaries of the partial images are recognisable, characterised in that there is provided a flat support surface (4) for the object and the beam-deflection means (5) are arranged substantially in the plane of the support surface in such a way that there is a view parallel to the support surface, which permits checking of the coplanarity of a plurality of parts (1.1) of the object, which are towards the support surface.

8. An apparatus as set forth in claim 7 characterised in that there is provided a single image-recording device (2), relative to which the object (1) is positioned in such a way that it fills only a partial region of its field of view which is determined by the viewing angle (3), and that disposed in remaining parts of the field of view are beam-deflection devices (5) which project side views (1b) of the object on to the image-recording device.

9. An apparatus as set forth in claim 7 or claim 8 characterised in that the beam-deflection means have prisms (5) or mirrors which in particular are displaceable and/or have curved surfaces.

10. An apparatus as set forth in claim 7 or claim 8 characterised in that the beam-deflection beams have a light guide device.

11. An apparatus as set forth in one of claims 7 through 10 characterised in that associated with at least one of the beam-deflection means are means (6) for changing the imaging scale of at least one partial

image with respect to at least one other partial image, in particular a lens arrangement.

12. An apparatus as set forth in one of claims 7 through 11 characterised by a lighting device (8a, 8b, 9) which in particular has a light diffuser device (9) for producing a uniform light flux under the object (1), which is arranged behind projecting parts (1.1) of the object.

13. An apparatus as set forth in claim 12 characterised in that the light diffuser device (9) is interrupted in such a way as to permit a view on to the side of the object (1), which is remote from the or all image-recording device or devices (2).

14. An apparatus as set forth in one of claims 7 through 13 characterised in that the image-recording device (2) and the storage and evaluation unit (7) are integrated to form a structural unit.

Abstract

A method for automated detection and checking of geometrical and/or textural features of an object (1) in various views (1a, 1b), in particular in side views and a plan view, using an opto-electronic image-recording device (2) as well as a storage and evaluation unit (7) for image processing and image evaluation, wherein quality or state assessment of the object is effected by a comparison with parameters which are predetermined in respect of the individual features and wherein a plurality of partial images of the object are substantially simultaneously recorded by means of a number of image-recording devices and beam-deflection means, which number is smaller than the plurality of partial images, and at least partially optically assembled at the same time to form an overall image which shows all views and in which the boundaries of the partial images can be recognised, and the overall image is evaluated separately for checking the individual features in the boundaries of the partial images.

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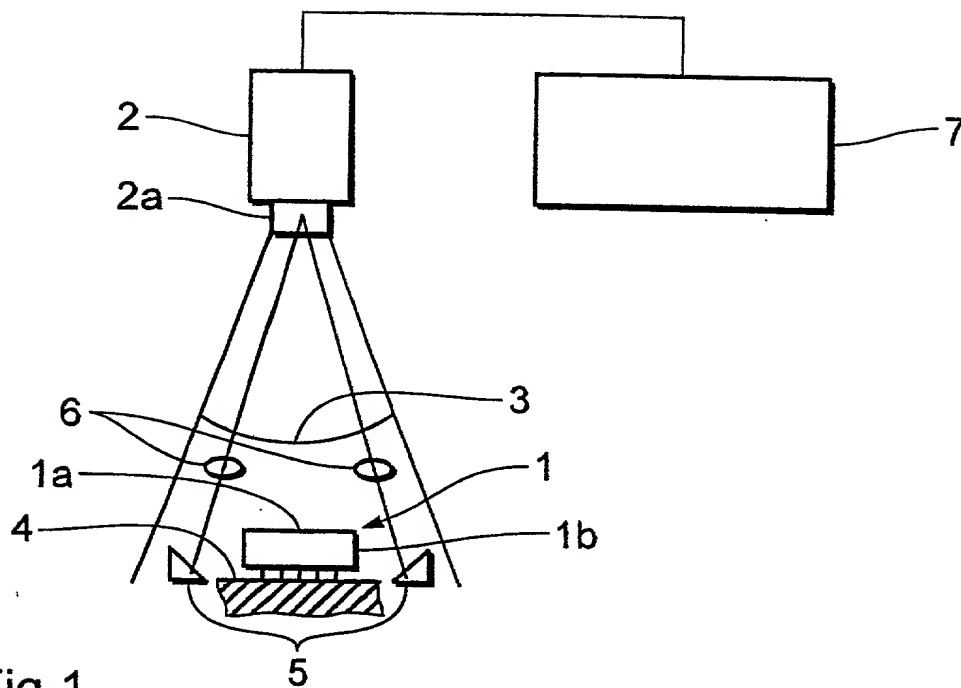


Fig. 1

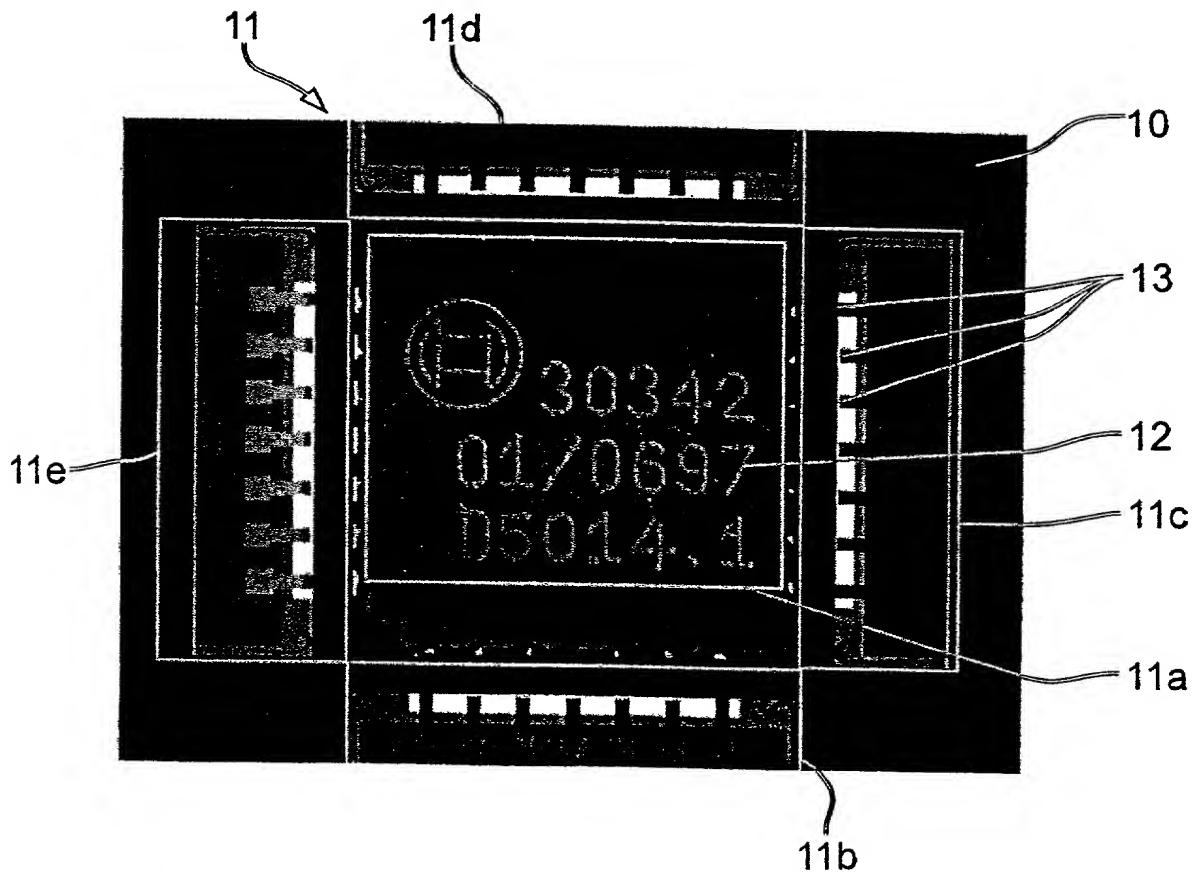


Fig. 2

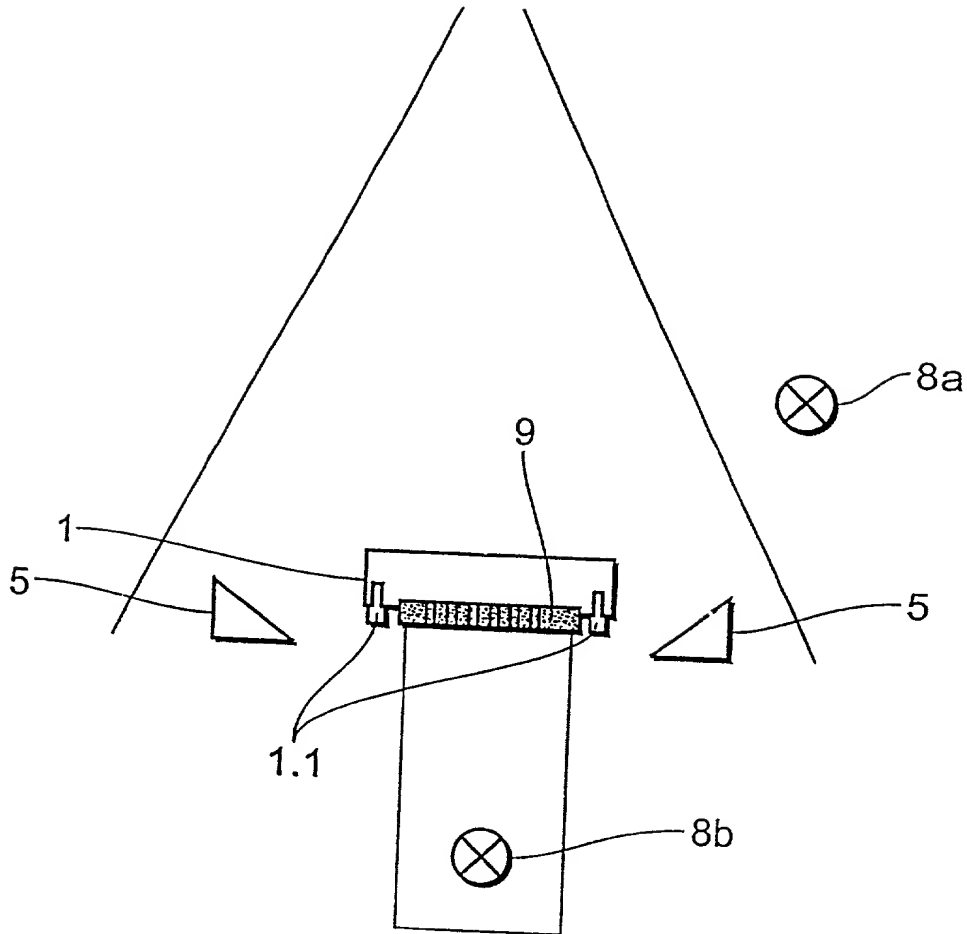


Fig.3

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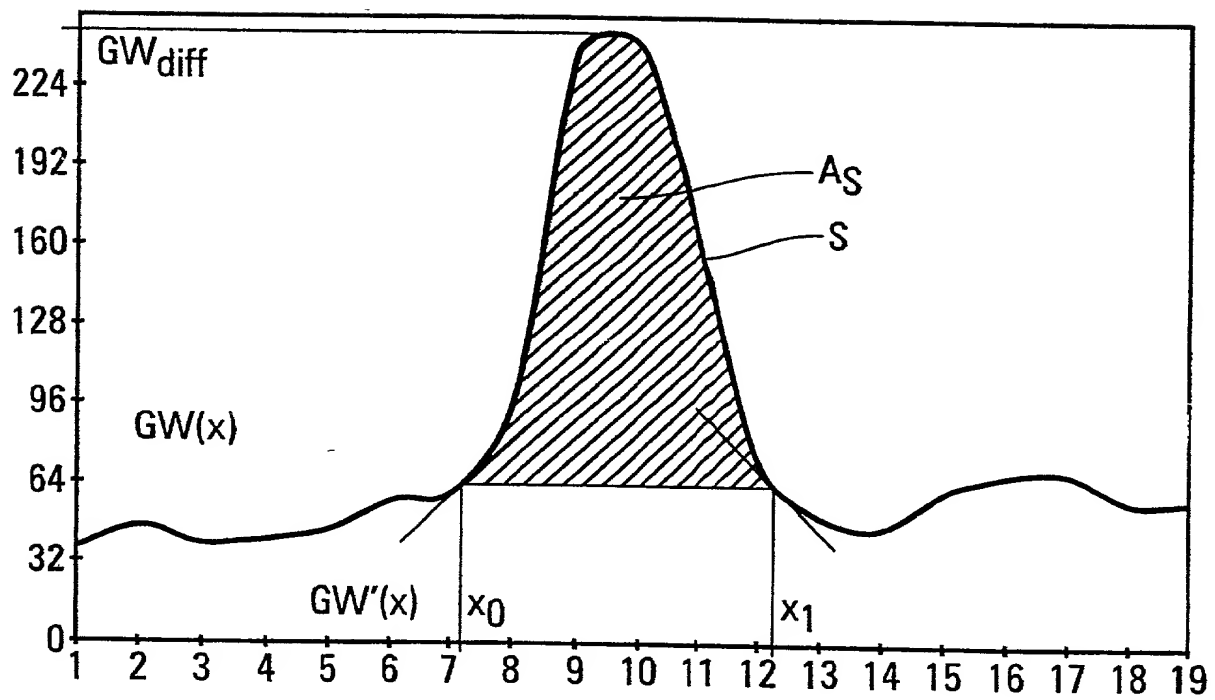


Fig.4

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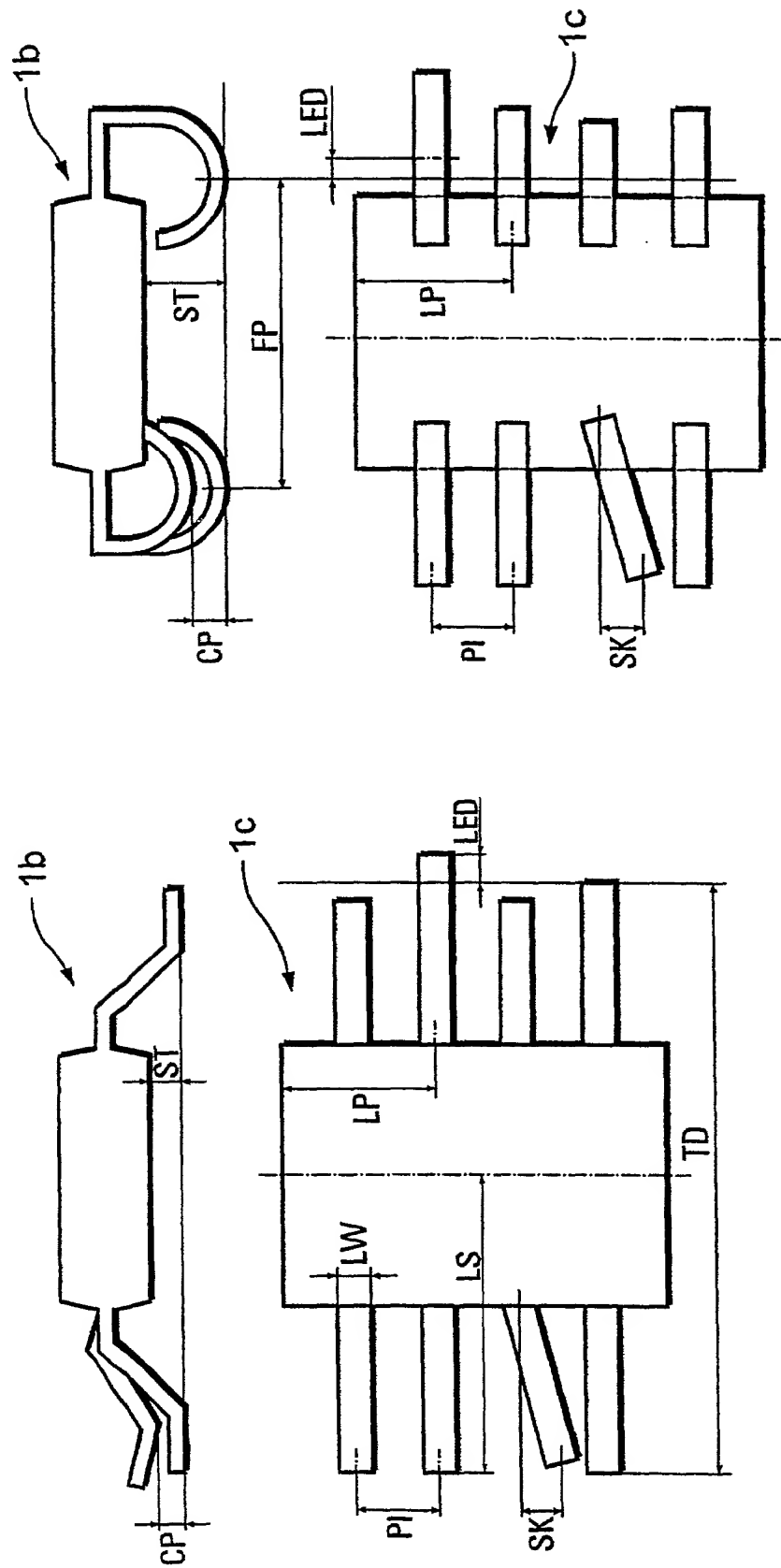


Fig.5

**DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATIONS**

PATENT

Docket No. : 40954/DBP/E43

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled METHOD AND DEVICE FOR AUTOMATIC DETECTION AND TESTING OF GEOMETRIC AND/OR TEXTURAL CHARACTERISTICS OF AN OBJECT, the specification of which is attached hereto unless the following is checked:

X was filed on May 17, 1999 as United States Application Number or PCT International Application Number PCT/EP99/03359 and was amended on July 17, 2000 (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of the foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)

<u>Application Number</u>	<u>Country</u>	<u>Filing Date (day/month/year)</u>	<u>Priority Claimed</u>
198 23 358.2	Germany	15/05/1998	YES

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below.

<u>Application Number</u>	<u>Filing Date</u>
---------------------------	--------------------

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

<u>Application Number</u>	<u>Filing Date</u>	<u>Patented/Pending/Abandoned</u>
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POWER OF ATTORNEY: I hereby appoint the following attorneys and agents of the law firm CHRISTIE, PARKER & HALE, LLP to prosecute this application and any international application under the Patent Cooperation Treaty based on it and to transact all business in the U.S. Patent and Trademark Office connected with either of them in accordance with instructions from the assignee of the entire interest in this application;

**DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATIONS**

Docket No. 40954/DBP/E43

or from the first or sole inventor named below in the event the application is not assigned; or from EISENFUHR, SPEISER & PARTNER in the event the power granted herein is for an application filed on behalf of a foreign attorney or agent.

45

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I declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

1-00

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